Model LTA

INST LAB PLT #4

INSTRUMENT
INSTRUCTIONS

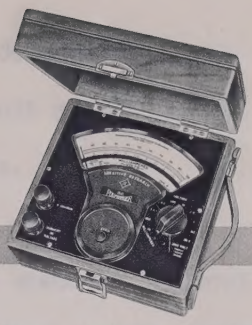
SENSITIVE RESEARCH INSTRUMENT CORPORATION
NEW ROCHELLE, N.Y.

ELECTRICAL INSTRUMENTS OF PRECISION SINCE 1927

Instrument No. 915595

ENSITIVE RESEARCH INSTRUMENT CORPORATION

Electrical Instruments of Precision



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MODEL LTA CONSOLE INSTRUCTION MANUAL

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I. INTRODUCTION

1. DESCRIPTION. The Model LTA Laboratory Standard Test Console is a wide range, precision instrument intended for use with a 1.5 volt potentiometer (Accuracy .01%) to measure AC and DC voltages and currents.

All measurements are referred to the potentiometer as the standard. Direct Current measurements are made using an internally switched potential divider for the voltage measurements and internally switched standard resistances for current measurements.

AC measurements are made using internally mounted vacuum thermocouples as AC to DC transfer devices; measurements of the DC substitution quantities are made by means of the potentiometric standards. Special compensation circuits are provided in both the voltage and current sections which eliminate errors due to variations of heater resistances with current level and permanent changes caused by overloads.

2. SPECIFICATIONS.

RANGES: .3-.75-1.5-3-7.5-15-30-75-150-300-750-1500 volts DC & AC at 100 ohms per volt and;

1.5-3-7.5-15-30-75 milliamperes DC & AC with 1.5 volt drop at full scale for all ranges.

.15-.3-.75-1.5-3-7.5-15-30 amperes DC & AC with 1.5 volt drop at full scale for all ranges.

Accuracy .05% of full scale values for AC or DC (except .3 volt range which is .1% for AC operation.)

For operation on DC and AC to 25,000 cycles.

Accessories required: 1.5 volt potentiometer, complete with standard cell, galvanometer, and battery.

3. CONTROLS.

CIRCUIT SELECTOR, 3 pos. switch. Selects DC or AC and controls AC-DC transfer.

MEASUREMENT SELECTOR, 6 pos. switch. Selects type of measurements to be made.

VOLTAGE RANGE SWITCH, 11 pos. Selects range of voltage measurements.

MILLIAMPERE RANGE SWITCH, 6 pos. Selects range of low current measurements.

AMPERE RANGE SWITCH, 5 pos. Selects range of high current measurements.

GALVANOMETER KEYS. Closes galvanometer circuit to indicate balance in thermocouple junction circuit. Has Coarse & Fine balance keys.

AC INPUT BALANCE CONTROLS Adjustment controls for the balancing voltage for the thermal junction output.

SUBSTITUTION BALANCE CONTROLS. Adjustment controls for the DC reference voltage.

POWER SUPPLY SWITCH. Controls power for the entire unit.

II. THEORY OF OPERATION

1. DC MEASUREMENTS.

a. DC VOLTAGE. DC voltages are fed directly to the potentiometer for voltages up to 1.5 volts. For higher voltages an internal potential divider drops the voltage to the 1.5 volt range of the potentiometer.

b. DC CURRENT. DC currents are passed through standard resistance and the resulting voltage drops read by means of the potentiometer. The drop is 1.5 volts for each full scale current range. This allows simple mental multiplying factors for the full scale ranges involved.

2. AC MEASUREMENTS.

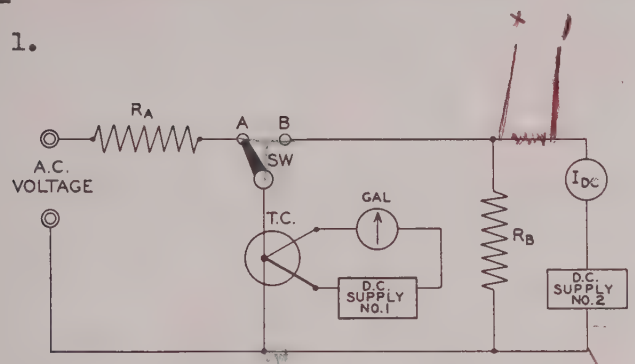
a. GENERAL. The circuits for AC voltage and current use vacuum thermocouples as AC to DC transfer devices. Vacuum thermocouples consist of a heater of fine wire, and a thermo-junction of two dissimilar metals. The junction of the dissimilar metals is attached to the center of the heater wire by means of an electrically insulating, but thermally conducting bead of material. The whole unit is enclosed in a small evacuated glass bulb. When a current is sent through the heater wire it reaches an elevated temperature and the attached thermal junction develops an output voltage proportional to the heat generated by the current in the heater. The output being dependent on the heater

temperature which is a square law function of the heater current, can be interpreted in terms of the true RMS value of the heater current. The RMS value of the alternating currents applied can then be evaluated by substituting a KNOWN DIRECT CURRENT. The direct substitution of DC for AC can achieve an accuracy of transfer of better than .01% for the AC - DC conversion. In order to achieve the wide range of voltage and current which can be measured with the LTA console, three different thermocouples are used, each being assigned a particular circuit.

The voltage transfer section uses a 10 milliampere thermocouple fed from an accurate voltage divider. This provides both a reasonable power consumption in the divider and a low enough impedance to give a wide frequency response. The current transfer section utilizes two additional thermocouples. A 1.5 milliampere thermocouple is used for the low current section, up to 75 milliamperes. Another 10 milliampere thermocouple is used for the higher currents above 75 milliamperes.

For voltage measurements, series resistance is added to the thermocouple heater circuit to obtain the desired ranges. For current measurements the heater is shunted by a series of accurate resistances to obtain the desired ranges. In both cases, the developed e.m.f. of the thermocouple junction is balanced out against an internal millivolt supply to obtain a "null" indication of the galvanometer. After a balance is obtained the heater is then switched to a second internal DC source and this source adjusted to RETURN THE GALVANOMETER AGAIN TO ZERO. The value of this DC current or voltage necessary to duplicate the junction output produced by the AC voltage or current is REFERENCED to the potentiometer for measurement. By a simple multiplying factor the DC potentiometer reading is converted to the AC input value.

b. AC VOLTAGE. The basic AC to DC voltage transfer circuit is shown in Figure 1.



BASIC A.C.-D.C. VOLTAGE TRANSFER CIRCUIT Fig. #1

If an AC voltage is impressed across R_A and the thermocouple heater by placing the switch in position "A", current will flow through the heater and produce a DC junction output voltage. DC supply No. 1 can be adjusted to give a stable output EXACTLY EQUAL and opposite to the couple output. At this point the galvanometer will indicate zero output, by a "null" reading (no motion of its light image.)

If we now change the switch (SW) to the "B" position and adjust DC supply #2 until the galvanometer returns again to zero (null), we know that the thermocouple output is again the SAME as when the switch was in position "A" and hence the heater current is now IDENTICAL to that which was produced by the original AC voltage.

In Position "A", $I_H = \dfrac{V_{AC}}{R_A + R_H}$

In Position "B", $I_H = \dfrac{I_{DC} \times R_B}{R_B + R_H}$

I_H = Heater Current
R_A = Range Resistor
R_H = Heater Resistance
V_{AC} = AC Input Voltage
I_{DC} = DC Reference Current
R_B = Compensation Resistor

Since the effective value of I_H is the same for both positions, then

$$I_H = \frac{VAC}{R_A + R_H} = I_{DC} \frac{R_B}{R_B + R_H}$$

If $R_A = R_B$, $VAC = I_{DC} R_A$

Thus, by using the compensation resistor R_B, the heater resistance R_H drops out of the formula and the accuracy of VAC depends only on R_A and I_{DC}.

c. AC CURRENT. The basic AC to DC current transfer circuit is shown in Figure 2.

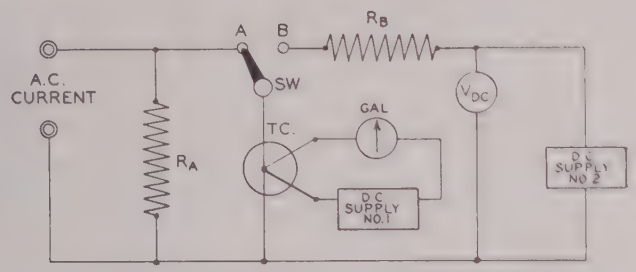


Fig. #2 BASIC A.C.-D.C. CURRENT TRANSFER CIRCUIT

For AC current a very similar circuit is used to eliminate the resistance of the thermocouple from the calibration accuracy. The circuit of this shown in Fig. 2. The AC current is put through a shunt "R_A" and a thermocouple is connected directly across the shunt when the switch is in the "A" position. Similar to the operation for AC volts, the thermocouple output is balanced to zero by means of a stable DC supply #1. The thermocouple is then switched to the "B" position and a DC voltage applied through a compensating resistance "R_B" to produce the same thermocouple output as evidenced by the return of the galvanometer to zero.

In position "A", $I_H = I_{AC} \times \frac{R_A}{R_A + R_H}$

In position "B", $I_H = \frac{V_{DC}}{R_B + R_H}$

Since the effective value of I_H is the same for both positions then,

$$I_{AC} \frac{R_A}{R_A + R_H} = \frac{V_{DC}}{R_B + R_H}$$

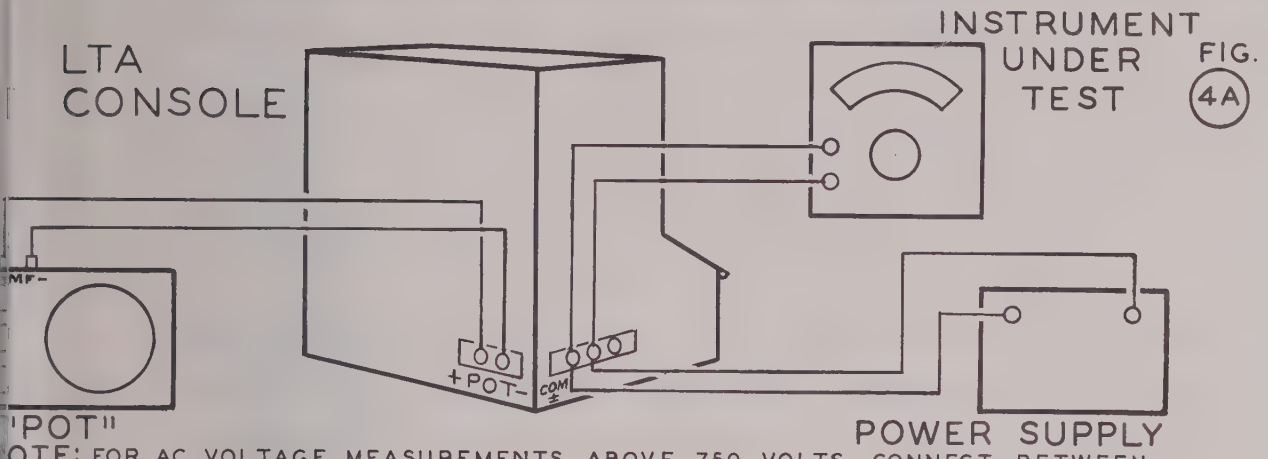
If $R_A = R_B$ $\frac{I_{AC}R_A}{R_A + R_H} = \frac{V_{DC}}{R_A + R_H}$ or $I_{AC}R_A = V_{DC}$

Therefore, using this circuit, I_{AC} can be determined knowing R_A and V_{DC} only. R_H does not appear in the final equation.

III. OPERATING INSTRUCTIONS

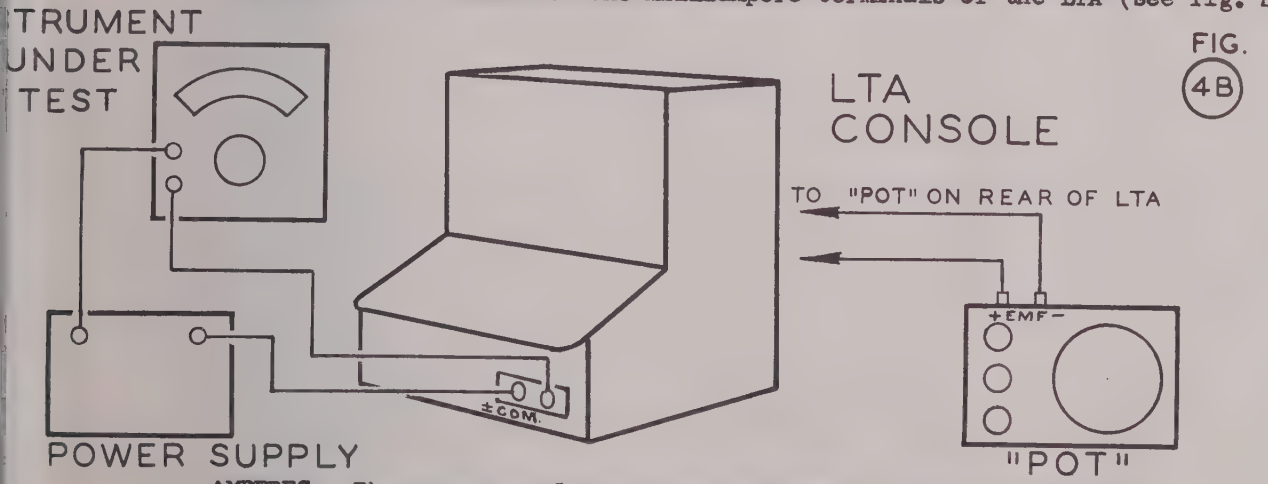
1. CONNECTIONS.

a. VOLTAGE. The power supply and the instrument to be calibrated are connected in parallel with the volt terminals of the LTA (see fig. 4A). For DC voltage below 1.5 volts it is recommended that the potentiometer be connected directly to the instrument terminals for best accuracy.

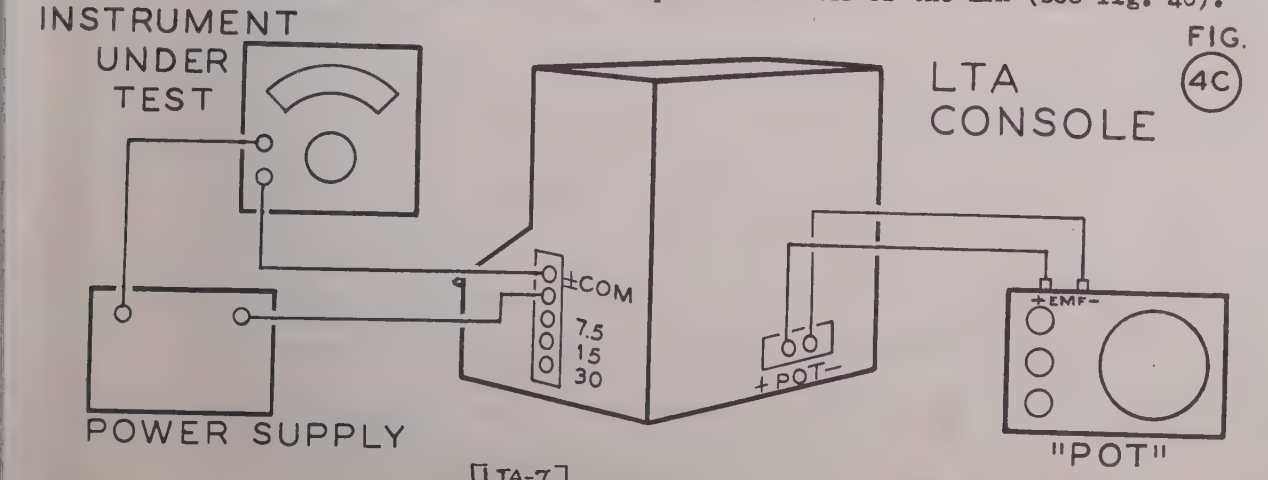


OTE: FOR AC VOLTAGE MEASUREMENTS ABOVE 750 VOLTS CONNECT BETWEEN MON & 1500 VOLT BINDING POST. SET VOLTAGE RANGE SELECTOR TO 750 VOLT POSITION.

b. MILLIAMPERES. The power supply and the instrument to be calibrated are connected in series with the milliampere terminals of the LTA (see fig. 4B).



c. AMPERES. The power supply and the instrument to be calibrated are connected in series with the ampere terminals of the LTA (see fig. 4C).



CAUTION! When making AC measurements, special care and technique is necessary due to the overload limitations and slow response time of thermocouples.

OVERLOAD LIMITATIONS. At rated current thermocouple heater wires run at a high temperature. If the heater current is doubled the heater temperature is 4 times normal and becomes dangerously high. For this reason when the circuit selector is in the AC input position, the voltage or current across the input terminals should never greatly exceed the range selector setting. Overloads of more than 100% will damage or probably burn out the thermocouple.

RESPONSE TIME. Since the DC junction e.m.f. of the thermocouple is dependent on the temperature of the heater wire, there will be a lag in response of about 15 seconds for the heater wire to reach thermal equilibrium. This will be evidenced on the LTA galvanometer whenever the heater current is varied. The AC measurements will therefore, be slower and require more care than the DC measurements.

III. PROCEDURE

Turn the power supply switch on and connect the potentiometer to the terminals on the rear of the console. Allow 15 minutes warm up for full accuracy.

a. DC VOLTAGE. -- (to calibrate)

1. Connect instrument and appropriate supply to the console as shown in Figure 4A.
2. Set circuit selector switch to DC position.
3. Set measurement selector to DC Volts position.
4. Set voltage range selector to desired range.
5. Set potentiometer using the range factor indicated on panel.
6. Adjust supply until the potentiometer voltage is balanced.
7. Read instrument.

b. DC VOLTAGE. -- (to read error)

1. Perform steps 1 through 5 of DC voltage calibration procedure.
2. Adjust supply until instrument indicates "on". (the desired point on its scale.)

3. Balance out voltage with the potentiometer slide wire and read error.

c. DC CURRENT. -- (to calibrate)

1. Connect instrument and appropriate supply to the console as shown in Figure 4B for milliamperes, or Figure 4C for amperes.

2. Set circuit selector switch to DC position.

3. Set measurement selector to DC milliampere for milliampere measurement or DC amperes for ampere measurement.

4. If measuring milliamperes then set the milliampere range selector to the desired range.

5. Set potentiometer using the range factor indicated on the panel.

6. Adjust supply until the potentiometer voltage is balanced.

7. Read instrument.

d. DC CURRENT. -- (to read error)

1. Perform steps 1 through 5 of DC Current calibration procedure.

2. Adjust supply until meter indicates "on". (the desired point on its scale.)

3. Balance out voltage with potentiometer slide wire and read error.

e. AC VOLTS. -- (to calibrate)

1. Connect instrument and appropriate supply to the console as shown in Figure 4A.

2. Set circuit selector switch to DC Substitution position.

3. Set measurement selector to AC volts position.

4. Set voltage range selector to desired range.

5. Set potentiometer using the range factor indicated on panel.

6. Adjust the DC Substitution controls until the potentiometer voltage is balanced.

7. Using first the coarse and then the fine galvanometer keys, adjust the AC input Balance controls until the galvanometer indicates null.

8. Turn circuit selector to AC input position.

9. Adjust the AC supply until the console galvanometer indicates a "null".

10. Read instrument.

f. AC VOLTS. -- (to read error)

1. Connect instrument and appropriate supply to the console as shown in Figure 4A.

2. Set circuit selector to AC input position.

3. Set measurement selector to AC volts position.

4. Set voltage range selector to desired range.

5. Set potentiometer using the range factor indicated on panel.

6. Adjust supply until instrument indicates "on". (the desired point on its scale.)

7. Using first the coarse and then the fine galvanometer keys, adjust the AC input balance controls until the galvanometer indicates a "null".

8. Turn circuit selector to DC substitution position.

9. Adjust the DC substitution controls until the galvanometer indicates a "null".

10. Balance out voltage with the potentiometer slide wire and read error.

g. AC CURRENT. -- (to calibrate)

1. Connect instrument and appropriate supply to the console as shown in Figure 4B for milliamperes or Figure 4C for amperes.

2. Set circuit selector to DC substitution position.

3. Set measurement selector to AC amperes or milliamperes.

4. Set milliamperes selector to the desired range if measuring milliamperes.

5. Set potentiometer using the range factor indicated on panel.

6. Adjust the DC substitution controls until the potentiometer voltage is balanced.

7. Using first the coarse and then the fine galvanometer keys, adjust the AC input balance controls until the galvanometer indicates a "null".

8. Turn circuit selector to AC input position.

9. Adjust the AC supply until the galvanometer indicates a "null".

10. Read instrument.

h. AC CURRENT. -- (to read error)

1. Connect instrument and appropriate supply to the console as shown in Figure 4B for milliamperes or Figure 4C for amperes.

2. Set circuit selector to AC input position.

3. Set measurement selector to AC amperes or milliamperes.

4. Set milliamperes selector to the desired range if measuring milliamperes.

5. Set potentiometer using the range factor indicated on panel.

6. Adjust supply until meter indicates "on". (the desired point on its scale.)

7. Using first the coarse and then the fine galvanometer keys, adjust the AC input balance controls until the galvanometer indicates a "null".

8. Turn circuit selector to DC substitution position.

9. Adjust the DC substitution controls until the galvanometer indicates a "null".

10. Balance out voltage with the potentiometer slide wire and read error.

INSTRUCTIONS FOR INSTALLING GALVANOMETER

Due to possibilities of damage in transit, the galvanometer for this instrument is shipped in a separate container. It must be installed in the test console in the following manner:

(1) Remove back panel from test set. This panel is held by screws around the edge which must be removed.

(2) Remove galvanometer from packing case, leave movement shorting wire connected to binding posts.

(3) Slide galvanometer halfway into the shelf provided. (First remove galvanometer retaining strip connected to top of shelf sideplates.)

(4) Connect leads from transformer under galvanometer shelf to two position terminal strip marked, "6 Volts".

(5) Slide galvanometer into position and replace galvanometer retaining strip.

(6) Remove shorting wire from galvanometer binding posts and connect galvanometer leads. Tagged lead is connected to the binding post nearest the front panel.

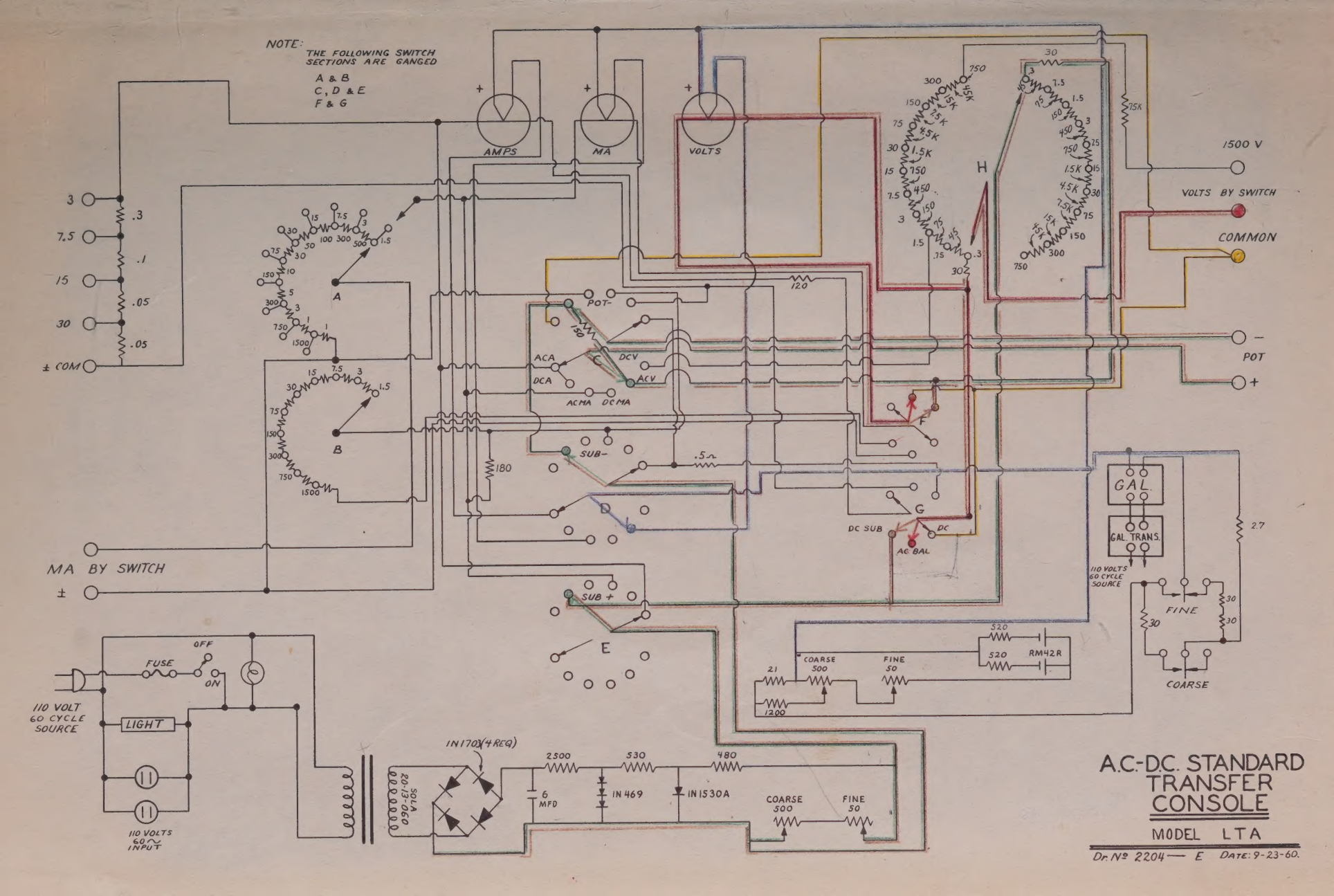
(7) Replace back panel on console.

ACHAL

A-V

THERMOCOUPLE TO DC SUPPLY NO 1 IN AC FINAL POSITION

DC SUB + ACV



A.C.-D.C. STANDARD TRANSFER CONSOLE

MODEL LTA

Dr. No 2204 — E DATE: 9-23-60.

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